

KEITHLEY

Model 135 Digital Multimeter Operator's Manual

MP MASTER



MA28564



Specifications

DC VOLTS

RANGE	MAXIMUM READING	ACCURACY 18°-28°C	TEMPERATURE COEFFICIENT 0°-18°C & 28°-50°C
2 V	1.9999	±(.05% + 1d)	±(.012% + .3d)/°C
20 V	19.999	±(.05% + 1d)	±(.012% + .3d)/°C
200 V	199.99	±(.1% + 1d)	±(.012% + .3d)/°C
1000 V	1000.0	±(.1% + 1d)	±(.012% + .3d)/°C

INPUT RESISTANCE: 10MΩ ±0.5%.

NMRR: Greater than 60dB @ 50Hz, 60Hz.

CMRR (1kΩ unbalance): Greater than 120dB @ DC, 50Hz & 60Hz.

MAXIMUM ALLOWABLE INPUT: 1000V continuous on 20V, 200V, 1000V ranges; 300V continuous on 2V range; 1000V momentary (3 seconds) on 2V range.

AC VOLTS (above 2000 counts)

RANGE	MAXIMUM READING	ACCURACY 18°-28°C
2 V	1.9999	±(1% + 15d), 45Hz-10kHz*
20 V	19.999	±(1% + 15d), 45Hz-500 Hz
200 V	199.99	±(1% + 15d), 45Hz-500 Hz
750 V	750.0	±(1% + 15d), 45Hz-120 Hz

* ±(5% + 15d), 10kHz-20kHz

RESPONSE: Average responding, calibrated in rms of a sine wave.

INPUT IMPEDANCE: 10MΩ ±.5% shunted by less than 100pF.

CMRR (1kΩ unbalance): Greater than 60dB @ DC, 50Hz & 60Hz.

MAXIMUM ALLOWABLE INPUT: 750V rms, 1000V peak continuous on 20V, 200V, 750V ranges, 10°V•Hz max; 300V rms continuous on 2V range, 750V momentary.

TEMPERATURE COEFFICIENT: Less than (0.1 × applicable accuracy)/(0°-18°C & 28°-50°C).

OHMS

RANGE	MAXIMUM READING	ACCURACY 18°-28°C	TEMPERATURE COEFFICIENT 0°-18°C & 28°-50°C	NOMINAL TEST CURRENT
2 kΩ	1.9999	±(.25% + 5d)	±(.05% + .3d)/°C	1 mA
20 kΩ	19.999	±(.2% + 2d)	±(.01% + .5d)/°C	100 μA
200 kΩ	199.99	±(.2% + 2d)	±(.01% + .5d)/°C	10 μA
2000 kΩ	1999.9	±(.2% + 2d)	±(.01% + .5d)/°C	1 μA
20MΩ	19.999	±(.25% + 2d)	±(.05% + .5d)/°C	0.1 μA

MAXIMUM ON-RANGE VOLTAGE: 2V.

MAXIMUM OPEN CIRCUIT VOLTAGE: 3.5V.

OVERLOAD PROTECTION: 300V AC or DC on all ranges.

DC AMPS

RANGE	MAXIMUM READING	ACCURACY 18°-28°C	TEMPERATURE COEFFICIENT 0°-18°C & 28°-50°C	BURDEN VOLTAGE
20mA	19.99	±(.5% + 2d)	±(.05% + .3d)/°C	.25V
10 A	10.00	±(1% + 2d)	±(.05% + .3d)/°C	.3 V

OVERLOAD PROTECTION: .75A fuse (250V), externally accessible.

AC AMPS

RANGE	READING	ACCURACY, 45Hz-1kHz 18°-28°C	TEMPERATURE COEFFICIENT 0°-18°C & 28°-50°C
20mA	1.999	±(1.5% + 15d)	±(.15% + 1.5d)/°C
10 A	10.00	±(1.5% + 15d)	±(.15% + 1.5d)/°C

OVERLOAD PROTECTION: .75A fuse (250V), externally accessible.

GENERAL

DISPLAY: 6" LCD digits with decimal and polarity indications, low battery warning.

CONVERSION PERIOD: 400ms.

OVERRANGE INDICATION: Flashing leading digit.

MAXIMUM COMMON MODE VOLTAGE: 500V.

OPERATING ENVIRONMENT: 0°-50°C; less than 80% relative humidity up to 35°C, less than 70% relative humidity from 35°-50°C.

STORAGE ENVIRONMENT: -35°C to 60°C.

POWER: One 9V transistor battery.

BATTERY LIFE: 100 hours (typical) with alkaline cell.

BATTERY INDICATOR: Display indicates "BAT" when less than 10% of life remains.

DIMENSIONS, WEIGHT: 178mm long × 78mm wide × 38mm thick (7.0" × 3.1" × 1.5"). Net weight 282gm (10 oz.).

ACCESSORIES SUPPLIED: Battery, test leads, operator's manual.

ACCESSORIES AVAILABLE:

- Model 1304 Soft Carrying Case & Stand
- Model 1359 Spare Parts Kit
- Model 1600 High Voltage Probe
- Model 1651 50A Current Shunt
- Model 1681 Clip-On Test Lead Set
- Model 1682 RF Probe
- Model 1683 Universal Test Lead Set
- Model 1685 Clamp-On Current Probe
- Model 1691 General Purpose Test Lead Set

Prices and specifications subject to change without notice.

SAFETY SYMBOLS AND TERMS

The symbol  on the instrument denotes that the user should refer to the operating instructions.

The symbol  on the instrument denotes that 1000V or more may be present on the terminal(s).

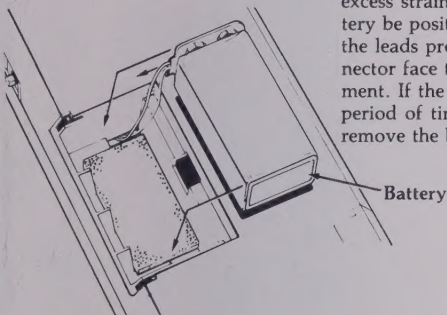
The **WARNING** used in this manual explains dangers that could result in personal injury or death.

The **CAUTION** used in this manual explains hazards that could damage the instrument.

Initial Preparation

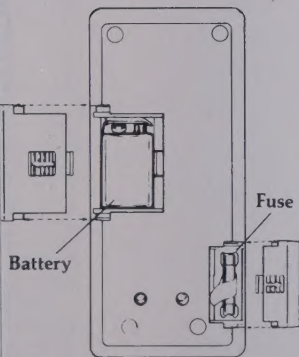
Battery Installation/Replacement

A 9V battery is supplied with the instrument but not installed. To install or replace the battery, remove the cover from the battery compartment by sliding it off in the direction of the arrow located on the battery cover. The battery connector snaps on and off the terminal of the battery. Improper installation of the battery will cause the connecting wires to be severed by excess strain. Proper installation requires that the battery be positioned in such a manner (see drawing) that the leads protruding from the boot of the battery connector face toward the outside of the battery compartment. If the instrument is going to be stored for a long period of time or in a high temperature environment, remove the battery to prevent leakage damage.



Fuse Check

With the instrument set to the $2k\Omega$ range connect a jumper from the V- Ω jack to the mA jack. The display should read approximately .0109. An overranged display would typically indicate a blown fuse. A display reading other than approximately .0109 could indicate a defective current input circuit (see schematic).



Fuse Replacement

To gain access to the fuse remove the fuse compartment cover in the same manner as removing the battery compartment cover. Remove the fuse by pulling outward on the plastic tab that encircles the fuse body. Install the plastic tab on the new fuse and snap the fuse back into the fuse holder. Do not replace the fuse with a higher rated value or instrument damage that is not covered by the warranty may occur.

WARNING

All service information is intended for qualified electronic maintenance personnel only.

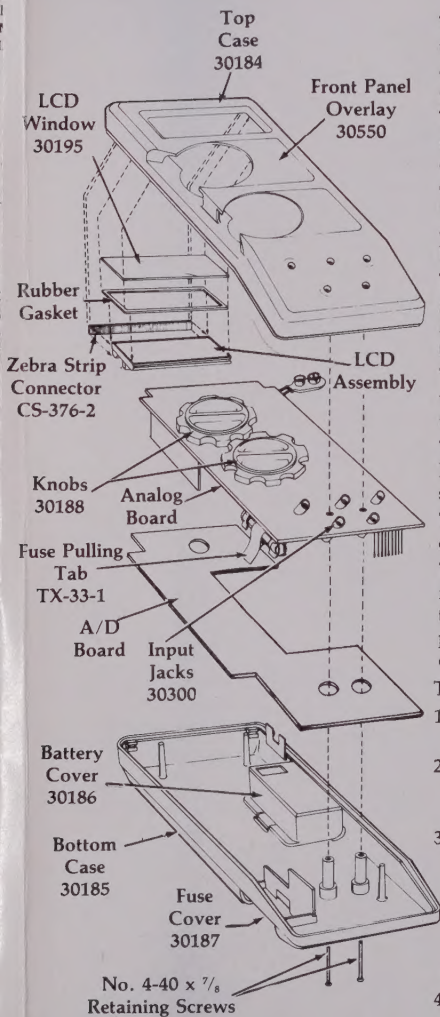
Calibration Procedure

RECOMMENDED TEST EQUIPMENT

Item	Description	Specification	Mfr.	Model
A	DC Calibrator	10V, 100V, 1000V $\pm 0.002\%$ or $2\mu V$	Fluke	343A
B	AC Calibrator	0.1V, 1V, 10V, 100V $\pm 0.022\%$	H-P	745A

Disassembly Instructions

Place the unit face down on a bench or other similar surface and remove the battery compartment cover. Disconnect and remove the battery. Remove the two No. 4-40 x 7/8 retaining screws. Grasp the bottom cover and lift gently at the input jack end.



Then GENTLY lift the bottom cover away from the PC board. The two latches securing the top and bottom cover will disengage. Lift the bottom cover completely away from the rest of the 135.

The battery can now be reconnected for troubleshooting and/or calibration. To read the display, some light downward pressure at the top end of the circuit board may be required in order to make contact, through the elastomer (zebra) contact strip, between the circuit board and the LCD.

To remove the PC boards from the top cover grasp the area around the switch assemblies and lift with a clockwise motion away from the bottom cover.

The LCD assembly will remain in the top cover when the PC boards are removed. Be careful that the LCD does not fall out.

The two switch knobs can be removed from the PC boards by simply pulling them off the switch shafts.

The LCD assembly, along with the zebra strip connector lifts out of the case.

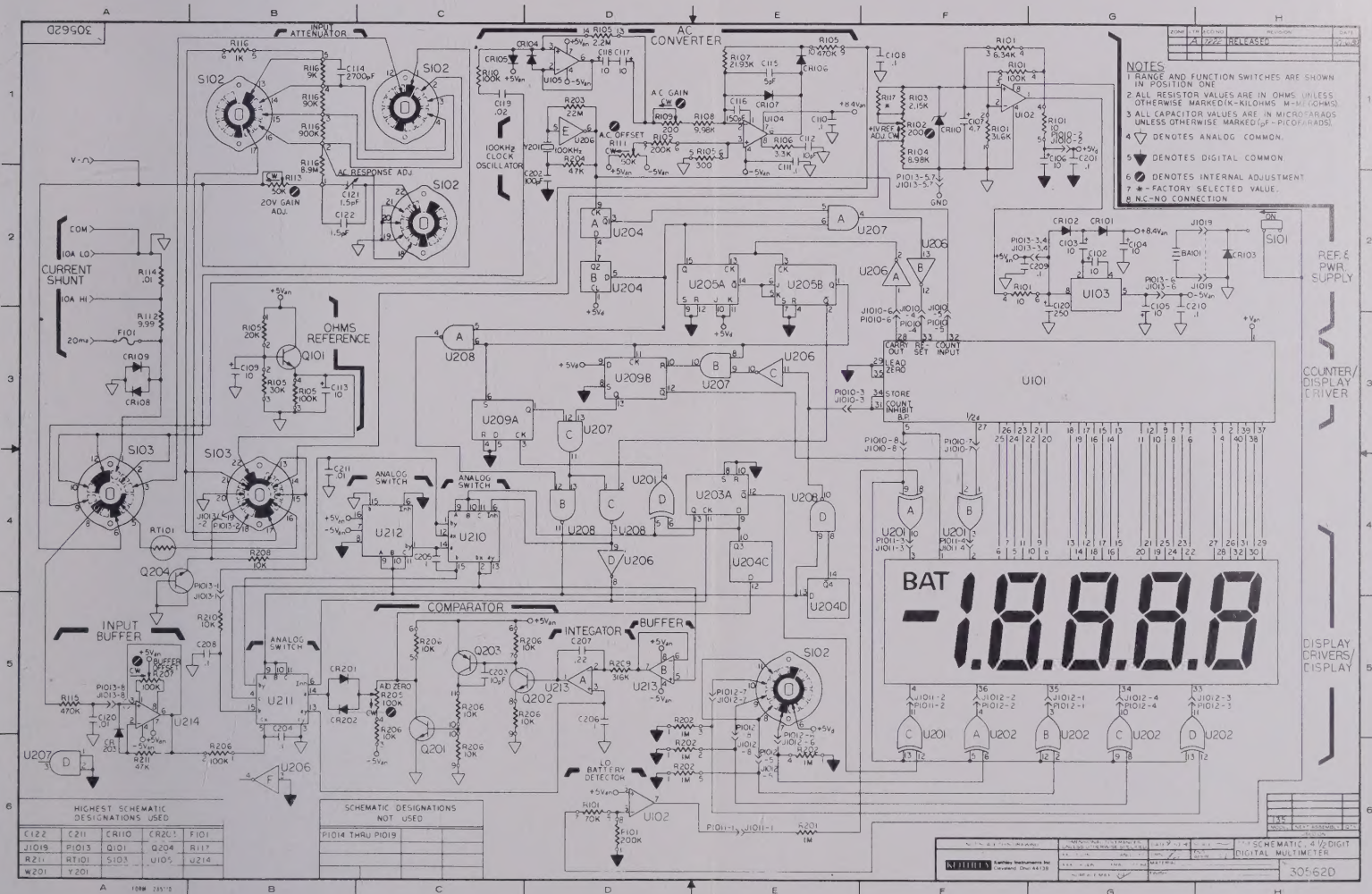
To separate the two PC boards from each other remove the two standoffs that secure them together. Gently pull the two boards apart at the points where they are connected (at the berg pin connectors).

To reassemble the 135:

1. Reconnect the two PC boards and reinstall the two standoffs.
2. Reinstall the two switch assembly knobs. Be sure the white dots on the knobs point toward the different ranges and functions.
3. Reinstall the LCD assembly into its proper place in the top cover as shown. Proper alignment of the zebra strip is necessary when reinstalling the LCD assembly. Make sure the conductor side of the zebra strip is positioned against the plastic support of the LCD assembly.
4. Reinstall the two PC boards into the top cover. Monitor the zebra strip alignment.

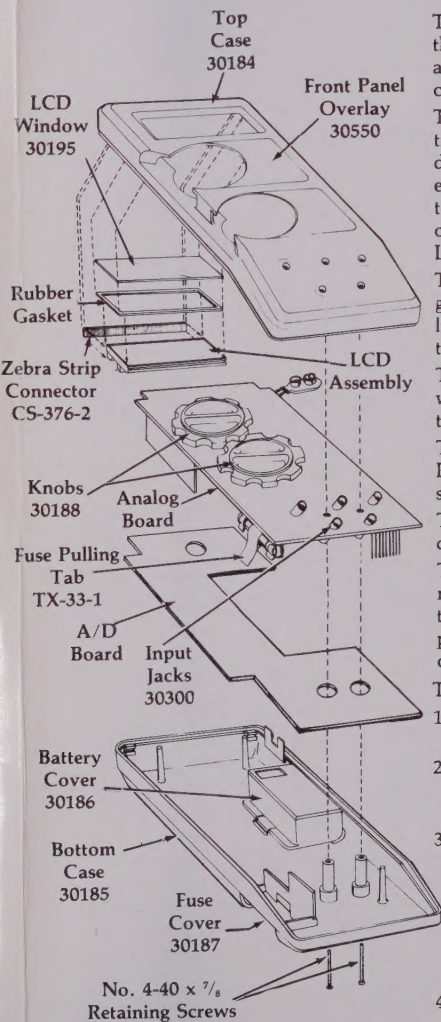
5. Feed the battery connector through the access opening in the bottom of the battery compartment which is located in the bottom cover.

Schematic



Disassembly Instructions

Place the unit face down on a bench or other similar surface and remove the battery compartment cover. Disconnect and remove the battery. Remove the two No. 4-40 x $\frac{7}{8}$ retaining screws. Grasp the bottom cover and lift gently at the input jack end.



Then GENTLY lift the bottom cover away from the PC board. The two latches securing the top and bottom cover will disengage. Lift the bottom cover completely away from the rest of the 135. The battery can now be reconnected for troubleshooting and/or calibration. To read the display, some light downward pressure at the top end of the circuit board may be required in order to make contact, through the elastomer (zebra) contact strip, between the circuit board and the LCD.

To remove the PC boards from the top cover grasp the area around the switch assemblies and lift with a clockwise motion away from the bottom cover.

The LCD assembly will remain in the top cover when the PC boards are removed. Be careful that the LCD does not fall out.

The two switch knobs can be removed from the PC boards by simply pulling them off the switch shafts.

The LCD assembly, along with the zebra strip connector lifts out of the case.

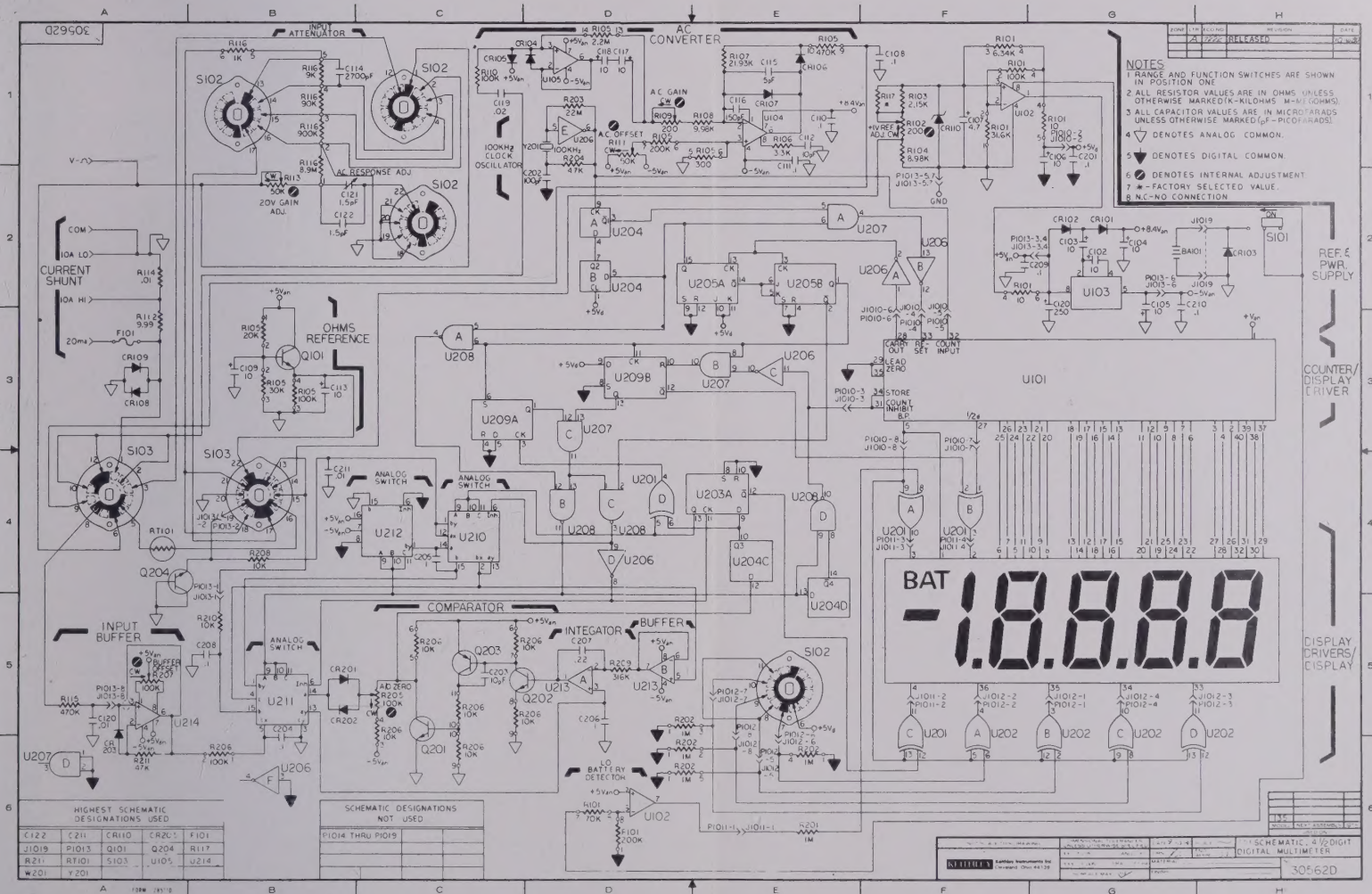
To separate the two PC boards from each other remove the two standoffs that secure them together. Gently pull the two boards apart at the points where they are connected (at the berg pin connectors).

To reassemble the 135:

1. Reconnect the two PC boards and reinstall the two standoffs.
2. Reinstall the two switch assembly knobs. Be sure the white dots on the knobs point toward the different ranges and functions.
3. Reinstall the LCD assembly into its proper place in the top cover as shown. Proper alignment of the zebra strip is necessary when reinstalling the LCD assembly. Make sure the conductor side of the zebra strip is positioned against the plastic support of the LCD assembly.
4. Reinstall the two PC boards into the top cover. Monitor the zebra strip alignment.

5. Feed the battery connector through the access opening in the bottom of the battery compartment which is located in the bottom cover.

Schematic



Disassembly Instructions (cont.)

6. Turn the 135 face down with the display end pointing toward yourself. Grasp the bottom cover at the top and hinge the bottom cover to the top cover at about a 45 degree angle. Apply a forward pushing and closing motion with the heel of your hand to snap the two covers together.
7. Reinstall the two No. 4-40 x $\frac{7}{8}$ retaining screws.
8. Reconnect the battery and put the battery compartment cover back in its place.

Performance Verification (cont.)

Utilize the following tables to check the performance of the 135. Apply the specified input to the appropriate input jacks. Verify that the readings are within the limits specified in the tables.

PERFORMANCE VERIFICATION TABLES

Table One

Range	Input	Allowable Readings
2VDC	1.0000V	.9994 to 1.0006
20VDC	10.000V	9.994 to 10.006
200VDC	100.00V	99.89 to 100.11
1000VDC	1000.0V	998.9 to 1001.1

Table Two

Range	Input	Allowable Readings
2 k Ω	1.0000 k Ω	.9970 to 1.0030
20 k Ω	10.000 k Ω	9.978 to 10.022
200 k Ω	100.00 k Ω	99.78 to 100.22
2000 k Ω	1000.0 k Ω	997.8 to 1002.2
20M Ω	10.000M Ω	9.973 to 10.027

Table Three

Range	Input	Allowable Readings
2VAC	1.0000V at 10kHz	.9885 to 1.0115
2VAC	1.0000V at 20kHz	.9485 to 1.0515
20VAC	10.000V at 500Hz	9.885 to 10.115
200VAC	100.00V at 120Hz	98.85 to 101.15
750VAC	750.0V at 120Hz	727.0 to 772.0

Table Four

Range	Input	Allowable Readings
20mA AC	10.00mA	9.70 to 10.30
10A AC	10.00A	9.70 to 10.30

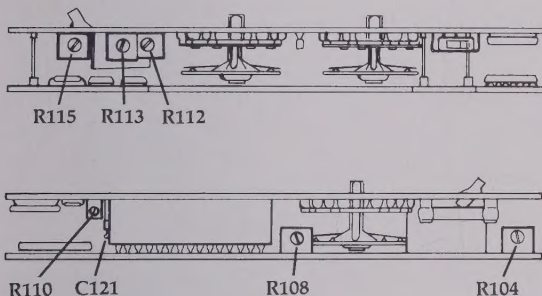
Table Five

Range	Input	Allowable Readings
20mA DC	10.00mA	9.70 to 10.30
10A DC	10.00A	9.70 to 10.30

Calibration Procedure (cont.)

1. Select the DCV function and also select the 1000V range.
2. Short C106 and adjust R108 for 0000.
3. Select the 2V range and short the input terminals (V- Ω , COM). Adjust R110 for 0000.
4. Remove the short from the input terminals. Apply + 1.9000VDC and adjust R104 for +1.9000.
5. Select the 20V range and apply +19.000VDC. Adjust R115 for +19.000.
6. Select the ACV function and the 2000V range. Short the input and adjust R113 for 0000.
7. Select the 2V range. Apply 1.9000VAC at 500Hz and adjust R112 for 1.9000VAC.
8. Select the 20V range. Apply 19.000VAC at 500Hz and adjust C121 for 19.000VAC.

SIDE VIEW OF CALIBRATION ADJUSTMENTS



Performance Verification

The performance verification can be performed upon receipt of the instrument to ensure that no damage or misadjustment has occurred during transit. Verification can also be performed whenever there is question of the instrument's accuracy, and following calibration, if desired.

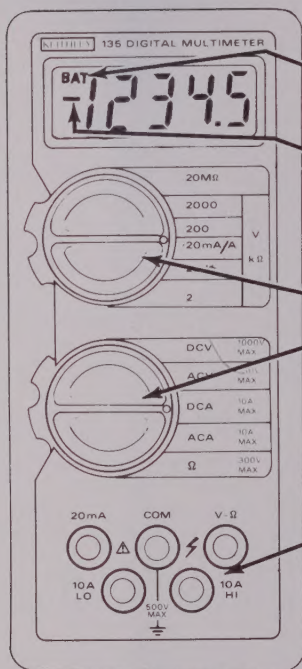
RECOMMENDED TEST EQUIPMENT FOR PERFORMANCE VERIFICATION

Item	Description	Specification	Mfr.	Model
A	DC Calibrator	10V, 100V, 1000V $\pm 0.002\%$ or $20\mu\text{V}$	Fluke	343A
B	AC Calibrator	0.1V, 1V, 10V, 100V $\pm .022\%$	H-P	745A
C	High Voltage Amplifier (Used with Model 745A)	750V, $\pm 0.04\%$	H-P	746A

Environmental Conditions

0° to 50°; at less than 80% Relative Humidity up to 35°C, less than 70% Relative Humidity from 35°C to 50°C.

Operating Instructions



Low Battery Indicator

Plus sign implied

Minus sign displayed

1. SET POWER ON

(Slide switch located on the side of the 135)

2. SELECT FUNCTION AND RANGE

DCV - 2V, 20V, 200V or 1000V

ACV - 2V, 20V, 200V or 750V

NOTE: 750V rms is the maximum allowable AC input.

DCA - 20mA, 10A

ACA - 20mA, 10A

3. INPUT

Select the appropriate pair of input jacks.

COM, V-Ω jacks are for all voltage and resistance measurements.

COM, mA jacks are for current measurements on the 20mA range.

10A COM, 10A HI jacks are for current measurements up to 10A.

SAFETY PRECAUTIONS

- Do not exceed the instrument's maximum allowable inputs as defined in the Specifications.
- Do not apply more than 500V peak above earth ground to the COM input jack.
- Turn the 135 off and disconnect the test leads before replacing the battery or fuse. Put the covers back into place on the compartments before resuming use of the instrument.
- Exercise extreme caution when a shock hazard is present at its input. The American National Standard Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30 volts rms or 42.4 volts peak are present.
- A good safety practice is to expect that hazardous voltages are present in any unknown circuit to be measured, until actual conditions are verified.
- The battery and fuse are accessible from the bottom of the instrument. Note the precautions on the case before installing or replacing either.

SERVICE POLICY

For service on your Model 135 DMM, contact your local representative who will be able to give you immediate assistance in most cases. Complete repair and calibration facilities are maintained in Cleveland, Ohio; Munich, West Germany; and Reading, United Kingdom, as well as first line repair service in Palaiseau, France. Information concerning the application, operation or service of your instrument may be directed to the applications engineer at any of the above locations.

WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace, at our option, any instrument or part thereof which, within a year from date of shipment, proves defective upon examination. We will pay local domestic surface freight costs. (NOTE: This warranty does not cover battery replacement or damage due to battery leakage.)

Accessories

MODEL 1304 SOFT CARRYING CASE AND STAND for the Model 135; also includes a condensed operator's instruction card.

MODEL 1359 SPARE PARTS KIT is a collection of specially selected parts to maintain up to ten Model 135 DMMs for one year.

MODEL 1600 HIGH VOLTAGE PROBE extends the DMM to 40kV. It has a 1000:1 division ratio, which means that 1 volt on the DMM corresponds to 1 kilovolt.

TO OPERATE: Set the DMM to DCV and appropriate range. Connect the banana plug on the Model 1600 to the input jacks. Connect the alligator clip on the Model 1600 to source LO. Connect the probe tip to source HI.

SPECIFICATIONS, MODEL 1600
VOLTAGE RANGE: 0 to 40,000VDC.

INPUT RESISTANCE: 1000 M Ω .

DIVISION RATIO: 1000:1.

RATIO ACCURACY:

$\pm 1.5\%$ at 25kV, decreasing to

$\pm 2.0\%$ at 20kV and 30kV

$\pm 3.0\%$ at 10kV and 40kV, and

$\pm 4.0\%$ at 1kV.

RATIO STABILITY: $\pm 0.01\% / ^\circ\text{C}$,
 $\pm 0.1\% / \text{year}$

HEATING EFFECTS: Self-heating due to application of high voltage for period in excess of 1 minute will cause a maximum of 0.2% additional error at 40kV (error is less at lower voltage).

MODEL 1651 50-AMPERE SHUNT allows current measurements to be made up to 50-amperes. It is a 0.001 ohm $\pm 1\%$ 4-terminal shunt. When the DMM is set to the 2 volt range, a 50-ampere current will correspond to 50 millivolts (.0500 volts).

TO OPERATE: Connect separate current leads (not furnished) between the source and the Model 1651 hex-head bolts. Use leads that are rated up to 50-ampere capacity. Connect the voltage leads (furnished) between the Model 1651 screw terminals and the DMM input jacks. Set the DMM to ACV or DCV and 200mV range.

MODEL 1681 CLIP-ON TEST LEAD SET contains two leads, 1.2m (48 inches) long, terminated with banana plug and spring action clip-on probe.

MODEL 1682 RF PROBE allows voltage measurements from 100kHz to 100MHz with the Model 135.

TO OPERATE: Set the DMM to DCV and appropriate range. Connect the Model 1682 to the DMM input jacks.

SPECIFICATIONS, MODEL 1682
VOLTAGE RANGE: 0.25 to 30V rms.
TRANSFER ACCURACY: $\pm 0.5\text{dB}$,
100kHz to 100MHz peak responding
calibrated in rms of a sine wave.
INPUT IMPEDANCE: 4M Ω shunted
by 3pF.

MAXIMUM ALLOWABLE INPUT:
30V rms AC, 200V DC.

ACCESSORIES SUPPLIED: Straight
tip, hook tip, ground clip, HI adapter,
banana plug adapter.

MODEL 1683 UNIVERSAL TEST LEAD KIT consists of two test leads, 1.2m (48 inches) long with 12 screw-in tips—2 banana plugs, 2 spade lugs, 2 alligator clips with boots, 2 needle tips with chucks and 4 heavy-duty tip plugs.

MODEL 1685 CLAMP-ON AC CURRENT PROBE measures AC current by clamping onto a single conductor. Interruption of the current path is unnecessary. The Model 1685 detects current by sensing magnetic field produced by current.

TO OPERATE: Set the DMM to ACV and appropriate range. Connect the Model 1685 to the DMM input jacks. The DMM will display 0.1V rms per ampere.

Specifications, Model 1685

RANGE: 2, 20 and 200 amperes rms.

ACCURACY: $\pm 4\%$ of range at 60Hz,
 $\pm 6\%$ of range at 50Hz.

TEMPERATURE COEFFICIENT:

$\pm 0.05\% / ^\circ\text{C}$ on the 20 and 200

ampere ranges. $\pm 0.3\% / ^\circ\text{C}$ on the 2
ampere range.

**MAXIMUM ALLOWABLE CUR-
RENT:** 300 amperes rms.

MAXIMUM CONDUCTOR

VOLTAGE: 600 volts rms.

CONVERSION RATIO: 0.1V rms per
ampere.

MODEL 1691 GENERAL PURPOSE TEST LEAD SET consists of two .91m (36 inches) test leads with probe tips terminated in banana plugs.

KEITHLEY

Document Number 30563

Keithley Instruments, Inc./28775 Aurora Road/Cleveland, Ohio 44139/(216) 248-0400/Telex: 98-5469

Keithley Instruments GmbH/Heiglhofstrasse 5/D-8000 München 70/(089) 714-40-65/Telex: 521 21 60

Keithley Instruments, Ltd./1, Boulton Road/GB-Reading, Berkshire RG2 0NL/(0734) 86 12 87

Keithley Instruments SARL/44, Rue Anatole France/F-91121 Palaiseau Cedex/01-014-22-06/Telex: (842) 204188

